An Economic Comparison of Cloud Network Architectures

PTC 2013 - Monday, Jan 21 - 14:00-15:30

Topical Session 1 – Networks & Cloud

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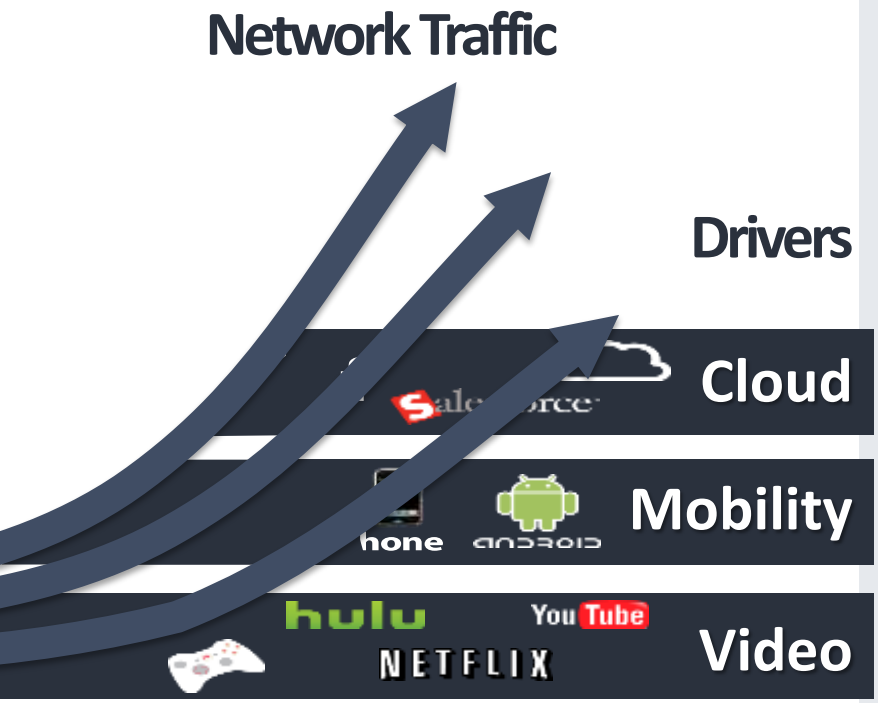
Cloud's Impact on Networks



- Cloud & virtualization rapidly transforming networking
  - Rise of the data center
  - Traffic profiles evolving
  - User experience matters
- Network infrastructure key to success
  - Scalable cost model across whole network essential
  - Cost/bit continuously evolving at various networking layers
- **Aggregate** network economics critical metric
  - TCO (CapEx + OpEx)
  - Sensitivity to traffic changes

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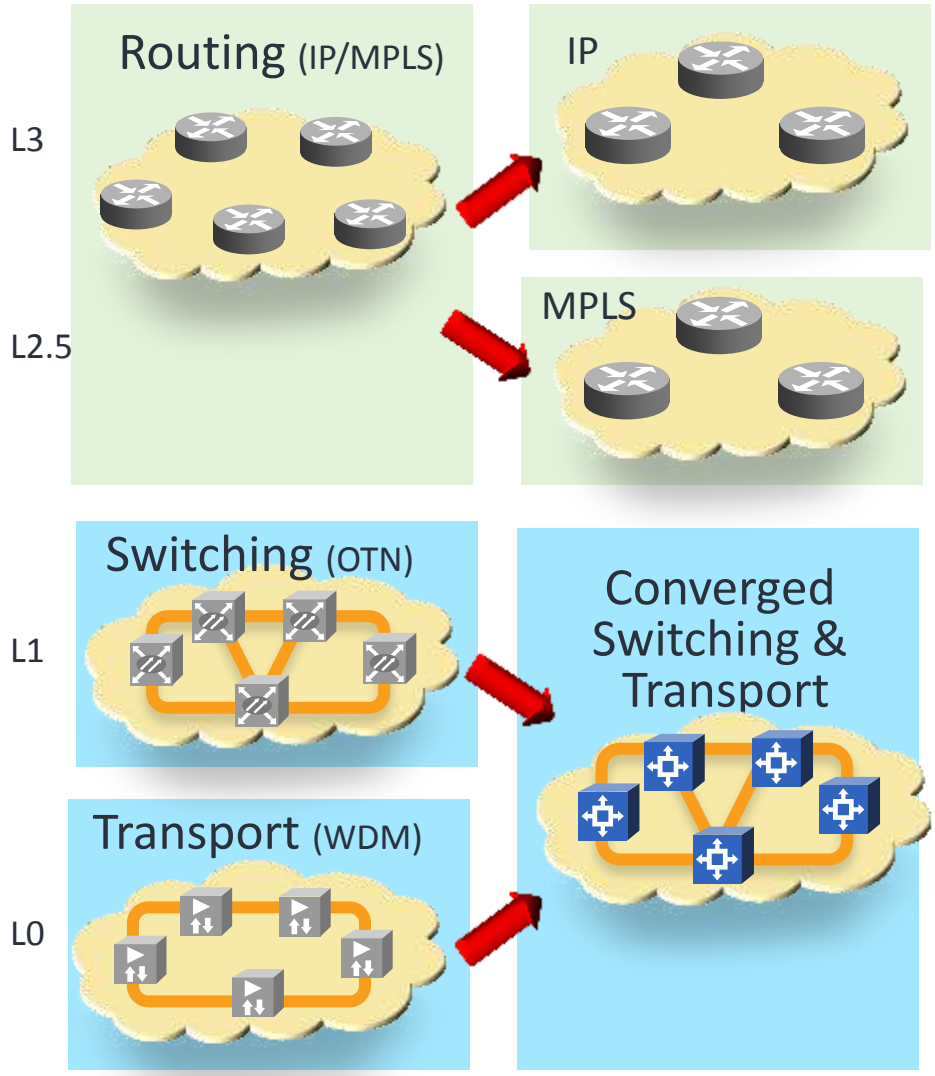
Network Layer Convergence Trends



- Industry driving convergence in Layers 0 - 2+, but divergence in Layer 2.5/3
- Integrated switching cost-effectively introduces flexibility into transport
  - Rapid bandwidth provisioning
  - Mesh networking
  - Virtualization & maximum utilization of wavelengths
  - Multiple protection schemes
- How does dynamic transport impact network economics?

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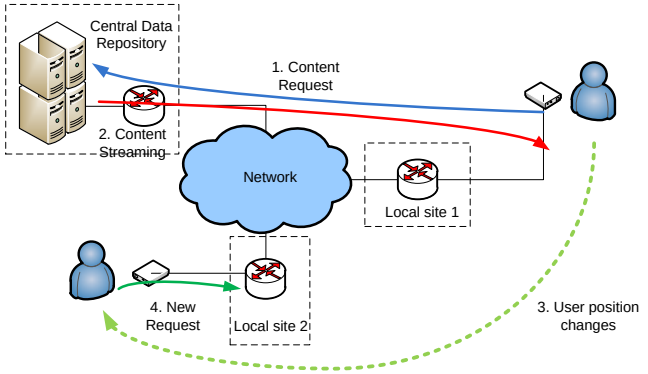
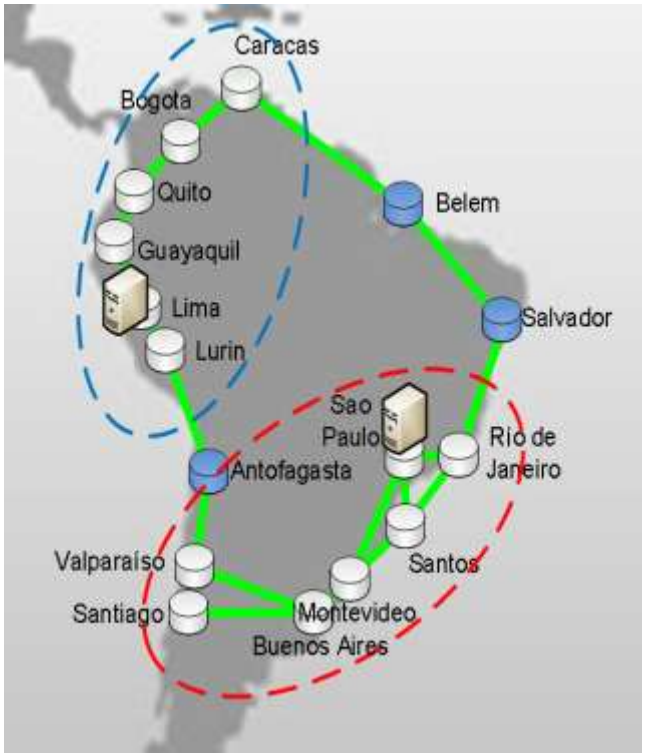
Telefonica Cloud Study





- Network traffic characteristics
  - **U2DC**: Virtual PC service w/ 2 DC's
    - Weighted traffic based on Internet usage data
  - **DC2DC**: M2M replication, inter-DB*
    - Night-time operations
  - **DC2DC Bulk**: VM migration†
    - 10000 VMs/DC, burst during day
  - Multi-yr growth extrapolated*
- A+B router backbone model
  - Resiliency left to fully redundant router backbone
- Relative costs based on multi-layer cost model study‡ & market data
  - Line amplifier systems & router switch fabric costs omitted

*Cisco GCI report

†Virtual Machine Mobility with Vmware Vmotion and Cisco DCI Technologies

†‡F. Rambach, B. Konrad, L. Dembeck, U. Gebhard, M. Gunkel, M. Quagliotti, L. Serra and V. López: A Multi-Layer Cost Model for Metro/Core Networks, to be published in IEEE/OSA Journal of Optical Communications and Networking

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Comparative Architectures

IPoWDM-f (baseline)

- IP + integrated colored optics + Fixed OADM
- Integrated 100G coherent WDM
- Analog demarcation between IP & transport layers

IPoWDM-c

- IP + integrated colored optics + Reconfigurable OADM
- Non-blocking 100G wavelength granular switching
- Analog demarcation between IP & transport layers

IPoOTN

- IP + integrated OTN/WDM switch
- 500G PIC-based super-channels
- 10/40/100GbE router interfaces
- Grey optics interconnect
- Digital demaracation between IP & transport layers

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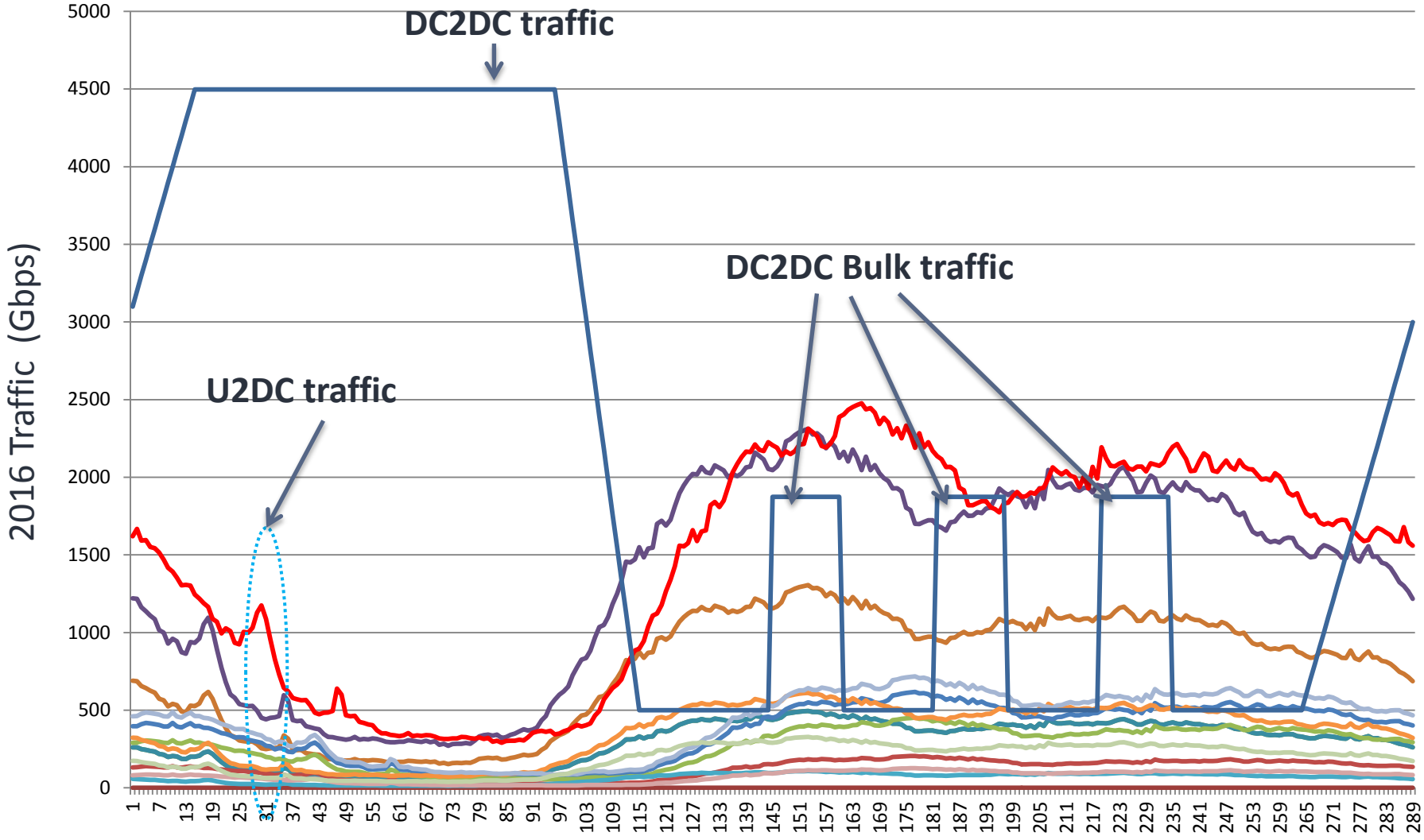
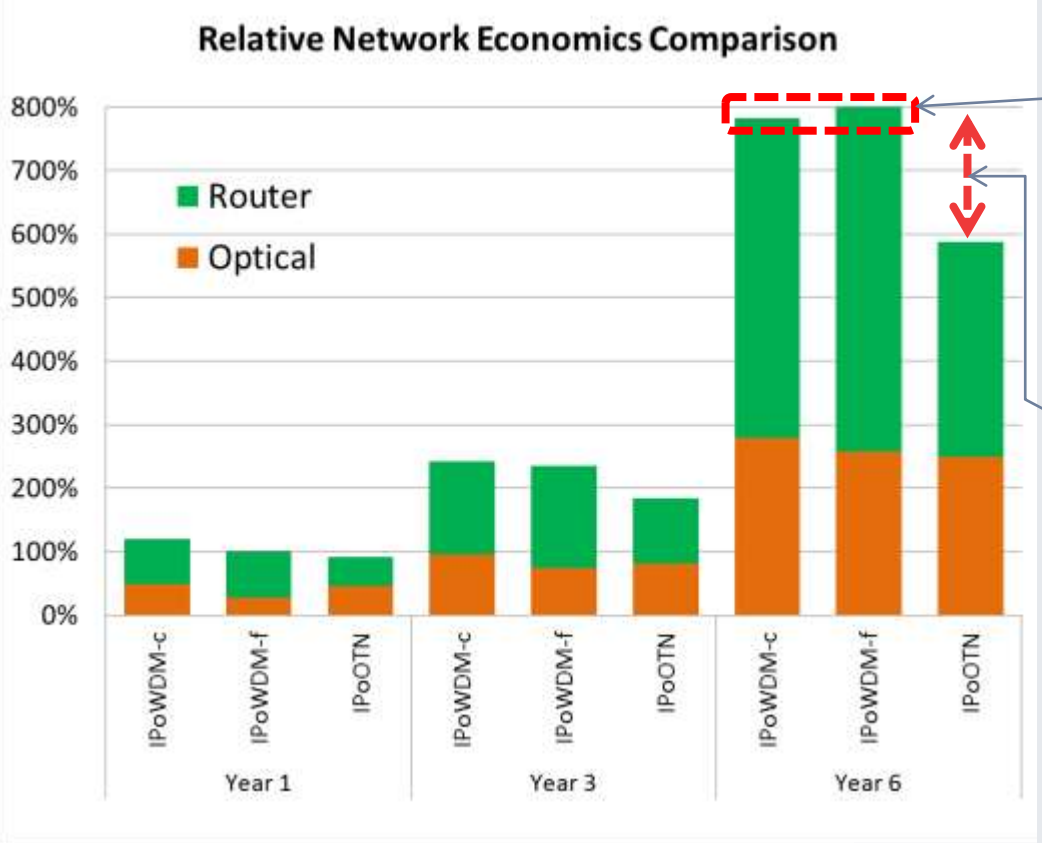
Case Study Traffic Profile
Dual Data Center Hubs



Modeling Results & Observations



Observations

- U2DC traffic pattern all hub-spoke
  - Single destination limited opportunity for router interface re-use
  - Meshier networks & traffic patterns yield greater benefit
- IPoOTN reduced IP layer costs
  - Fewer total 100GbE blades
  - Mixed 10/40/100G router interfaces
  - PIC-based super-channels
- IPoOTN lays foundation for further savings
  - Shared Mesh Protection (SMP) can address overprovisioning in router backbone
  - Packet processing at ingress can aggregate packet flows & consolidate router ports

Key Results (Year 6)

- IPoWDM-c enabled **5-10%** savings over IPoWDM-f
- IPoOTN enables **20-30%** savings over IPoWDM-c

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Closing Remarks

- Today's optical transport layer can flexibly adapt to dynamic Cloud demands
  - Router interface reuse greatly dependent on traffic patterns
- IPoOTN can reduce ***total*** network costs
  - Relative cost/switching in IP vs Transport layers varies greatly
  - Integrated protection & packet awareness
  - Improved OpEx (space, power, etc.)
- Analysis of multi-layer architectures leveraging dynamic transport worthwhile
  - Complexity of 2 dynamic layers may be addressed by SDN

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Thank You!

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